



## 14<sup>th</sup> Annual OSC Readiness Training Program

# Detection

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Version  
OSC 2011

# Overview

- Types
- Causes
- Investigating and Monitoring
- Protocols and Data Evaluation
- Health and Safety Risks
- Preventative Measures

20 Greenhill Road Landfill  
Johnston, Rhode Island

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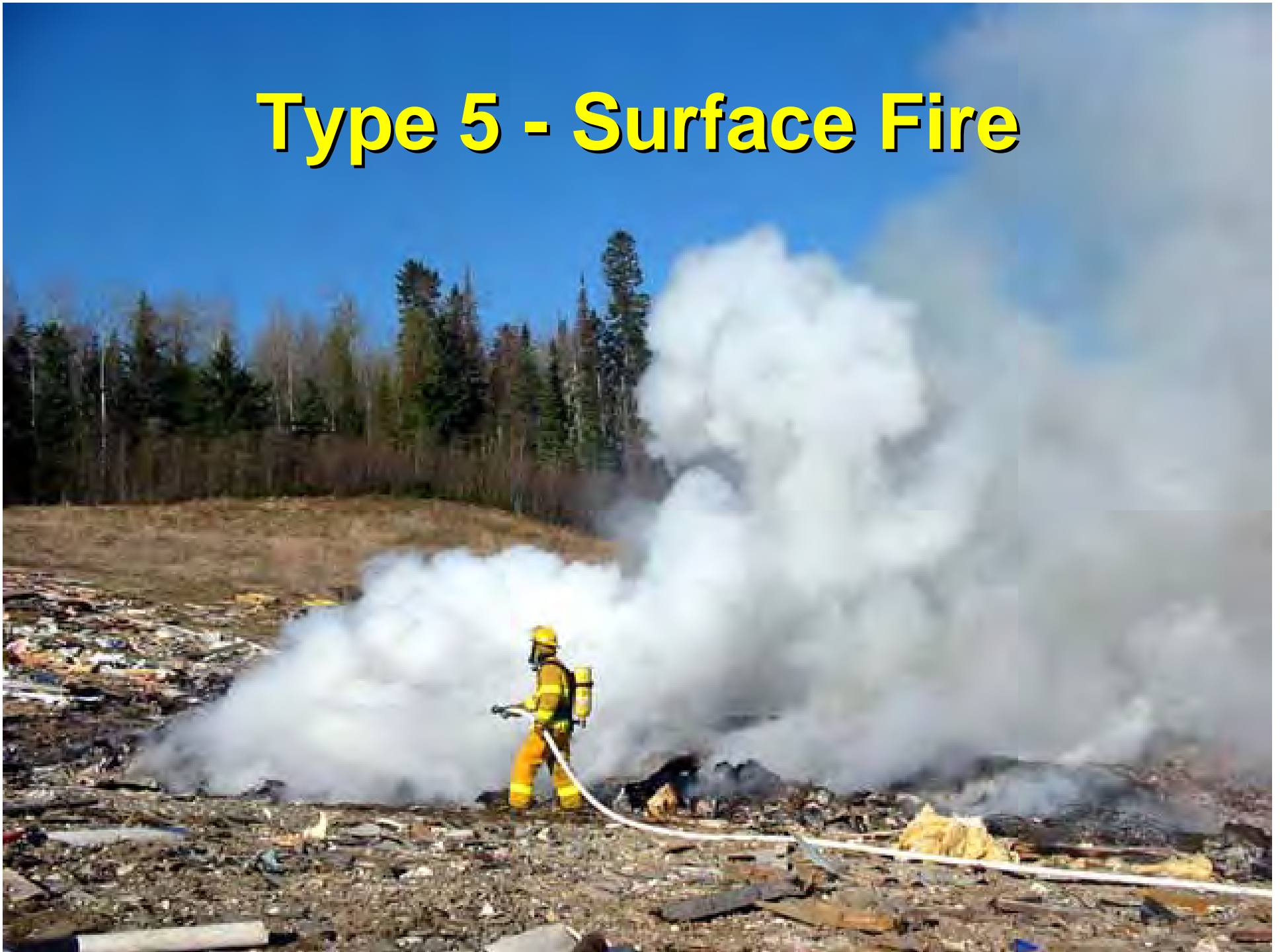
# Terminology

- Landfill Fires [Underground Fire]
  - Industry Term
  - 1<sup>st</sup> substantial paper in 1984, Sterns and Petoyan, Identifying and Controlling Landfill Fires, Waste Management Research
  - Later became “How to Find and Treat Subsurface Fires”, Waste Age 1984

# Surface Types (Per ICS -400)

- Type 0
  - Operational in nature, handled by operator \$
- Type 5
  - Visible smoke, additional resources, 911 called, 1 to 8 hours of suppression (1 Business Day) activities \$\$
- Type 4
  - 8 to 24 hours of suppression activities \$\$\$
- Type 3
  - Up to one week of suppression activities \$\$\$\$
- Type 2
  - More than a week of suppression activities \$\$\$\$\$

# Type 5 - Surface Fire



# Type 4





# Type 2 - Fresno



# Cause of Surface Fires

- Embers in a hot load;
- Careless smoking;
- Reactive substances;
- Methane flash from equipment spark;
- Arson; and
- **Spontaneous Combustion**





# Reactive Sawdust Load, Calgary

Source: Tony Sperling - [Landfillfire.com](http://Landfillfire.com)



## **Magnesium Chloride, Waste Connection, Ore.**

Source: Tony Sperling - [Landfillfire.com](http://Landfillfire.com)

# Subsurface

- Material burning below the surface in a waste pile
- Typically in C&D facilities
- Will find “worm holes” in the waste







# Subsurface Fire

- Difficult to locate
- Extinguishment is time consuming
- Create “worm holes”

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# Causes of Underground Fires

- Spontaneous combustion
- Inadequate cover
- **Over Pulling** of a GCS system
- Air/Oxygen intrusion through fissures or other features
- Previous surface fire

# Does the facility have a GCS

- This will help you determine the cause, extent and magnitude of the fire
  - LF fire with GCS are generally caused by over pulling
- Watch out for subsurface fires w/o GCS
  - Barometric influence and extended burning

# Most Common Cause Underground Fires (UF)

- Overpulling of a gas collection system



# Subsurface Fire Locations

- Typically fires at LF w/GCS are at slopes or grade breaks where the compaction and depth of soil is less than the main deck
- Or can occur at the well head if no seal is present

# LFG Operations

- Operator must balance the Compliance vs. Combustion Issue

Required to reduce/eliminate LFG emission



Excessive LFG extraction rates may produce a fire

# New Source Performance Standards (NSPS) [CITE: 40CFR60.753]

- Emission Guidelines for municipal solid waste landfills. ( $>2.5$  million  $\text{m}^3$ )
- Must Operate interior well at
  - LFG temperature of  $< 130$   $^{\circ}\text{C}$
  - Nitrogen level  $< 20$  percent or
  - Oxygen level  $< 5$  percent
- O/O may establish higher levels
  - Must be approved by administrator



# UF Potential

Increased Potential for a LF Fire to begin in an interior LFG extraction well if

- Oxygen exceeds 1.5% by volume
- Nitrogen exceeds 12% by volume
- Gas temperature exceeds 150-160 °F
- **Highest Potential** (all the above plus)
  - LFG well is on a slope with interim cover
  - Source: Todd Thalhamer, CIWMB

# Detecting a LF Fire

- Substantial settlement over a short time
- Smoke or smoldering odor emanating from the gas extraction system or landfill
- Levels of CO in excess of 1000 ppmv
- Combustion residue in wells and/or headers
- Increase in gas temperature in the extraction system (above 140° F or large  $\Delta T$ )
- Temperatures in excess of 170 ° F
- Oddities???

# Settlement Due to UF



# Collapse Feature Carmon Landfill – Israel



Source: Tony Sperling - [Landfillfire.com](http://Landfillfire.com)



# Settlement



# Smoke vs. Steam

- Color difference:
  - Smoke » bluish-grey
  - Steam » white-grey
- Time/Temperature of Observation
- Transparency and Smoke Dissipation
- Easily distinguished by a field CO monitor
  - Note: Method is for Ambient Air



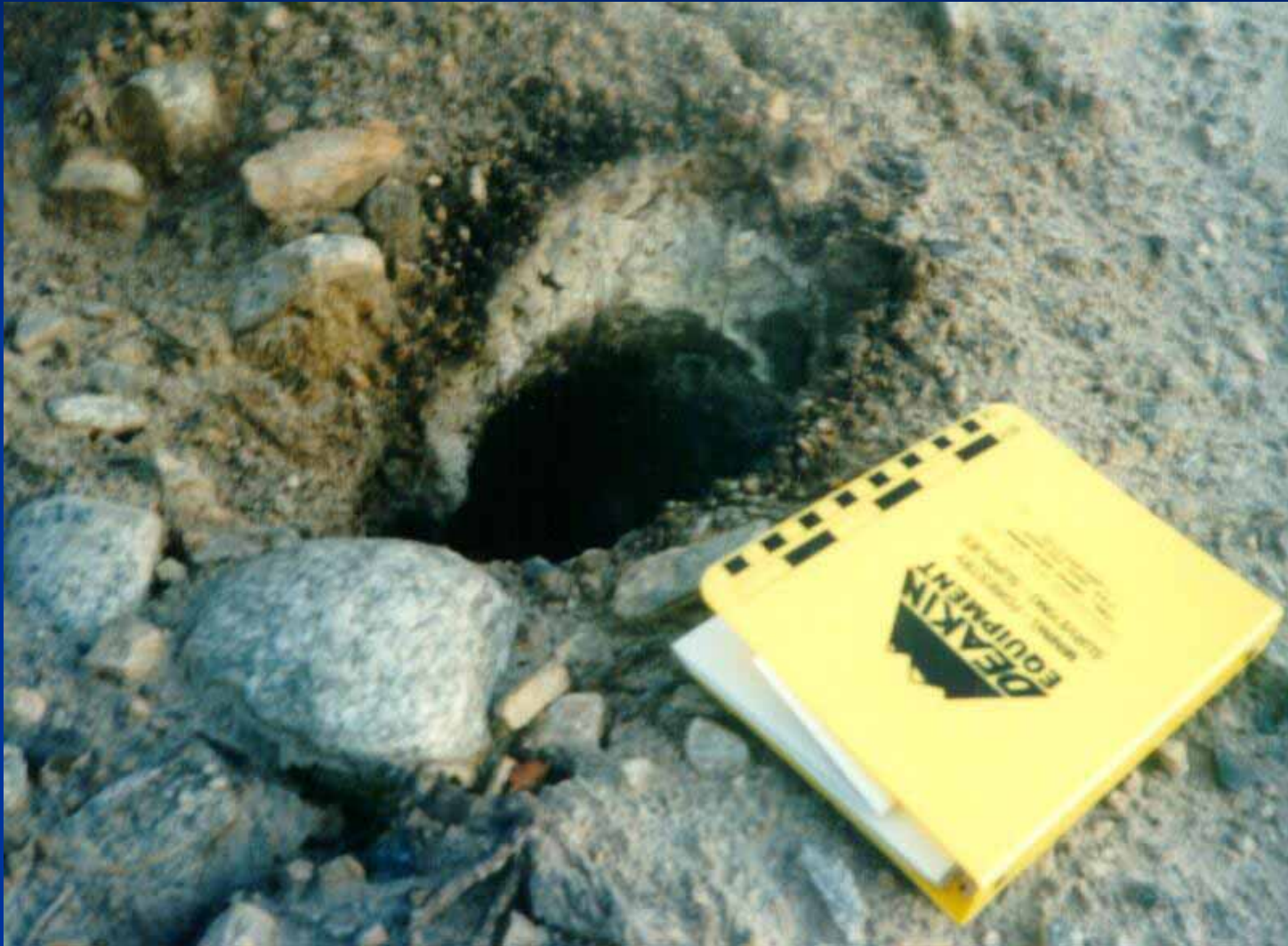
# Venting without smoke

Temperature is  
your evidence





# Combustion Residue



Source: Tony Sperling - [Landfillfire.com](http://Landfillfire.com)

# Protocols

## 1. Field Data

- Temperature surveys
- Gas sampling surveys
- Infrared surveys

## 2. Data Evaluation

- Tend Analysis



# Elevated Temperature



# Gas Sampling Protocol

- Primarily Carbon Monoxide
  - Detection level below 10 ppm
  - Notify lab high CH<sub>4</sub>
- Fixed Gasses - O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>
- Toxic Gasses – TO-14 and/or TO-15

# CO Monitoring

- Field instrumentation
  - Qualitative abilities and susceptible to cross-sensitivity with high T, H<sub>2</sub>S, and humidity
  - Must use a pre-filter
  - **Poor Results**
- Use Lab methods to determine CO
  - ASTM-D1946 (Low Detection Limit -10 ppmv)



# Field Sampling



# Data Evaluation

- The Landfill should have established base lines for LFG
  - Typically a landfill collects  $\text{CH}_4$ ,  $\text{CO}_2$ ,  $\text{O}_2$ , Temperatures, and balance gasses ( $\text{N}_2$ )
  - Freq varies but the data is available to plot over time
  - Look for trends in the wells and well fields

# Data Trends for UF

Past investigations have shown

1. Excess Oxygen or Nitrogen
2. A gradual increase in  $\Delta$ temperatures
3. Spike in  $\Delta t$
4. Decrease in  $\text{CH}_4$
5. Increase in CO

Not typically sampled but you would also see an increase in Benzene, MEK, and D/F

# Infrared Technology

- Does this work?
  - Yes, but depends on resolution and op
- Provides an excellent base map
- Limitations
  - Facility may be at 110 to 130 F
  - Soil cover may interfere
  - Look for large Temp  $\Delta$



# Infrared Examples





- 
- This is an aerial photograph of a landfill site. The image is overlaid with colored outlines and shapes representing different environmental features. A large, irregular red outline covers the central and right portions of the image, indicating underground fire areas. Several smaller red shapes are scattered within this area. Yellow shapes, representing unidentified thermal anomalies, are located in the upper left quadrant. Blue outlines, representing seepage areas, are found along the right edge and in the lower left. A vertical scale bar is on the left, and a text box with site information is at the bottom center.
- Underground Fire Areas
  - Unidentified Thermal Anomalies
  - Seepage Areas

20 Greenhill Road Landfill  
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- Underground Fire Areas
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# Other Indicators

- Infrared
- Elevated VOCs [2 to 3 Orders of Magnitude]
  - Benzene
  - MKE (2-Butanone)
- Elevated Dioxins / Furans
  - Costly Sampling
- Leachate Composition
  - Increases in constituents
- Changes in Groundwater Data
  - Damaged liner via heat or settlement

# Confirming a Subsurface Fire

- Rapid Settlement
- Temp above 170 F
- Levels of CO above 1000 ppm w/lab analysis
  - CO between 100 & 1000 ppm are viewed as suspicious
  - CO between 10 & 100 ppm, no active fire
- Infrared will not confirm a **FIRE**

# Health and Safety For Investigations

- H & Safety Plan
- Entering facility with explosive gas
- Use four gas meter w/CO
- UEL and LEL are present
- Intrinsically safe equipment
- Collapse Potential
- Confined Space





# Health and Safety Concerns

- Past sampling of fires have shown:
  - Temperatures in excess of 500 F
  - CO levels above 28,000 ppmv
  - H<sub>2</sub>S levels at 3,000 and 25,000 ppmv
- **Unsafe areas, possible collapse**, due to the void spaces created by the fire.

# Sink Holes

- 16 year old – three degree burns 30%
- Fell into 15 deep hole X-mas eve
- Equipment damage \$\$\$

## Youth slips into burning Bend sinkhole

□ Lyle Zimmerman, 16, is badly burned in an accident at a buried county landfill

*From staff and wire reports*

BEND — Workers have posted signs and fenced off the park district land where a 16-year-old boy fell into a burning sinkhole — the remnant of a buried county landfill.

Lyle Wayne Zimmerman, 16, suffered third-degree burns on his hands and other burns across 30 percent of his body in the Christmas Eve accident.

"Lyle doesn't remember much, but he told me he thought he had fallen into a 15-foot-deep hell hole," his mother, Mona Laager, said after the accident.

Zimmerman remained in serious condition Friday in the burn unit at Emanuel Hospital & Health Center in Portland.

Family members and friends questioned why the sinkhole had not previously been fenced off or marked with warning signs.

"Why the hell didn't they post the place?" asked Gene Draper, the father of another boy, Larry Draper, who was with Zimmerman when he fell.

"Anybody could have fallen into that hole," the elder Draper said. "It's a death trap up there."

Park district director Ernie Drapela said Friday his agency was very disturbed by the accident.

The district had planned to put children's baseball diamonds on an unused portion of the old landfill site, he said, but shelved the plan a year ago after conferring with the Department of Environmental Quality.

"This goes well beyond anything we had anticipated would happen," he said.

The park district was unaware of hot spots or sinkholes, he said.

Larry Draper said he and Zimmerman had noticed a thin trail of smoke coming from the ground while they were walking home Christmas Eve and went to investigate.

"There was a little hole there, and we were looking into it. Then the ground that Lyle was standing on fell in," Draper said.

"He yelled that he was on fire. ... There was just a lot of smoke. He reached his hand up, but I couldn't pull him up."

Passers-by helped him pull Zimmerman from the hole.

"It was really bad," Draper said. "His hands looked like there was gloves on them but there wasn't."

The Department of Environmental Quality will inspect the land next week.

The sinkhole is on a 13.75-acre parcel of park district land leased by Mount Bachelor Inc. on the outskirts of Bend.

The resort has its offices and shuttle van parking lot on the site. The remainder of the landfill area, about six acres, is unused.

Workers fenced off a half-acre, including the 5-foot-deep sinkhole, and more dirt was laid over the site.

The landfill was owned by the county and given to the park district. The dump was used for wood waste, such as shavings or lumber or chemicals used in wood processing, Drapela said.

The decomposing debris smoldered and ignited through spontaneous combustion, he said. Burned-out pockets cause the ground cover to weaken and collapse.

Most of the problem areas are along the edges of the landfill, where the earthen cap used to cover the waste is thinnest, he said.

"It just makes me sick because I've got four kids," Drapela said.

Laager, a single mother of two, said her son would require skin grafts and probably would be hospitalized at least a month.

She said her family was dependent on food stamps and had no health insurance.

"It's going to be a hard time, but he's alive — that's what we're thankful for," she said.

Drapela said the park district had met with its insurer and was determining the extent of its responsibility for the accident.

"The county and the district and Mount Bachelor are going to have to confer with insurance and legal people to clarify all these questions," Drapela said.

# Prevention

- Look for gravel pathways i.e. access roads
- Ensure soil compaction on slope
- Additional Cover  $> 1\text{ft}$  (low permeability soil)
  - Occurrence of UF, consider final cover
- Decrease extraction rate or shut down
- Increase monitoring frequency
- Prevent air intrusion through maintenance and well seals

# GCS Prevention

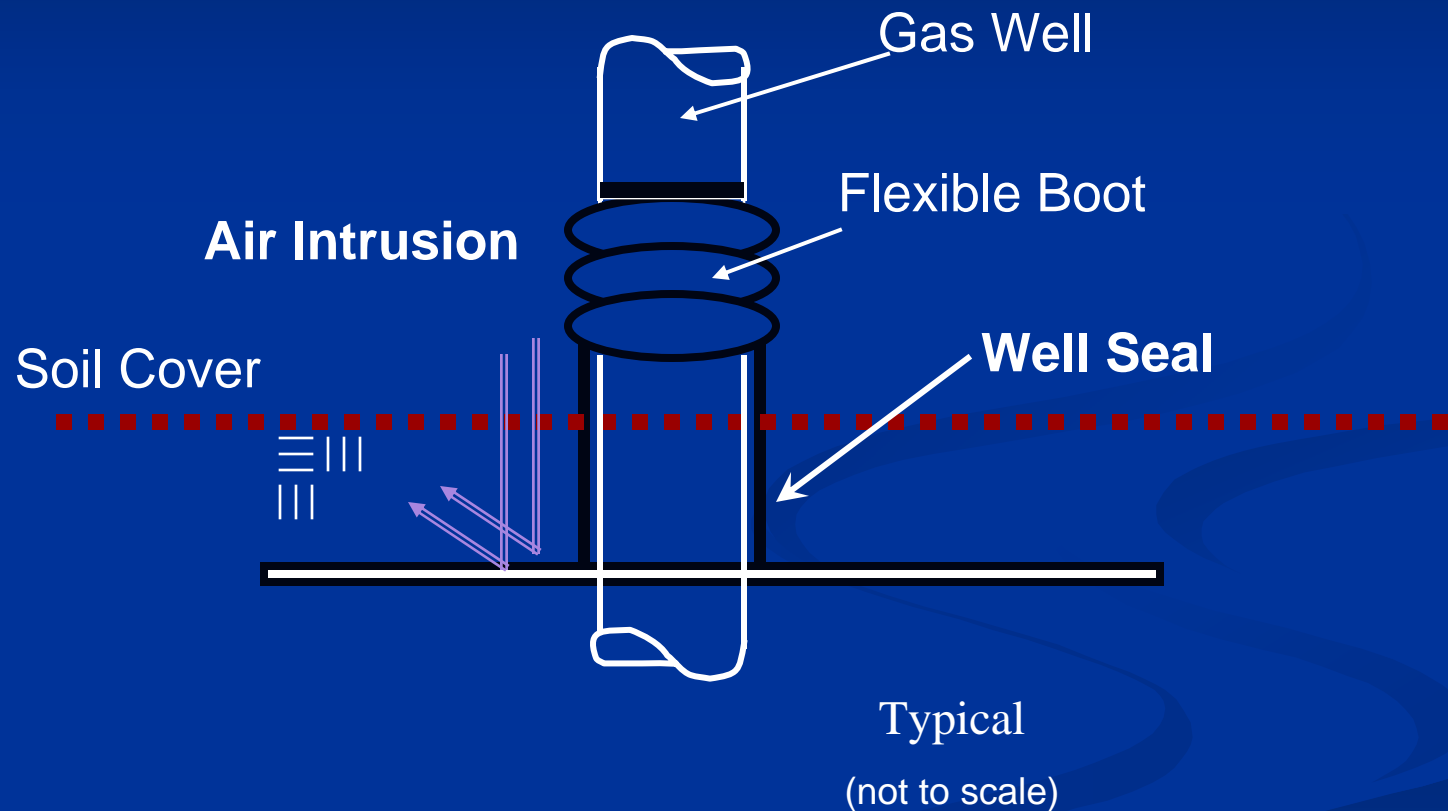
- Reduce oxygen to less than 1% for and interior well
- Reduce nitrogen to less than 10% for an interior well
- Reduce gas well temps below 135 F



# Prevention – Additional Soil

- Min Perm of  $1 \times 10^{-6}$
- Max particle size 3 inches
- Classified SC, ML, CL, CH
- Extend cover min 10 ft
- Min cover 24 inches
- Max lift 9 inches

# Well-Bore Seal



May consist of bentonite clay or  
geosynthetic membrane

# Questions

- Underground Landfill Fires
- Investigation Techniques
- Sampling Criteria
- Data Evaluation
- Prevention

FOR MORE INFO...

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